EPA RFA No. 07100

Quality Assurance Project Plan

Long Island Sound Water Quality Monitoring Phytoplankton Identification Project 2007-2008

Prepared by

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for

U. S. Environmental Protection Agency Region I
Office of Environmental Measurement & Evaluation

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Approving Officials

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LIS Water Quality Monitoring Phytoplankton Identification Project 2007-2008

A: PROJECT MANAGEMENT

1.1 Problem Definition

The Connecticut Department of Environmental Protection (CTDEP), with funding from the federal EPA Long Island Sound Study (LISS), has been conducting regular monitoring of Long Island Sound (LIS) since 1991. Through the fifteen years of monitoring, chlorophyll-*a* levels have shown wide fluctuations and periods of decline that appear to be unrelated to nutrient concentrations. A better understanding of phytoplankton populations will help determine if phytoplankton structure is shifting or if chlorophyll trends are simply an artifact of sampling schedules. Further, as nitrogen control plans are implemented, concerns over phytoplankton community shifts towards more or less desirable species can be documented and appropriate revisions of management plans made.

Phytoplankton samples were collected for identification and enumeration from November 2001 through October 2003, with analyses conducted by UCONN, and November 2003 through June 2005, with analyses conducted in-house by CTDEP. The current project ~~QAPP~~ is essentially the same as the project undertaken in 2002 with UCONN to analyze samples from the period November 2001 through October 2003, with minor modifications. This project will expand the Long Island Sound phytoplankton database and provide for improved understanding of seasonal and annual variability. In addition, the phytoplankton community data is valuable for interpreting results of ongoing HPLC phytopigment analyses funded by EPA's National Coastal Assessment.

1.2 Project Description

Water samples are currently collected from 17 locations throughout LIS on a monthly basis as part of the CTDEP LIS Ambient Water Quality Monitoring Program. A portion of whole water samples already being collected by the Monitoring Program for nutrient analyses will be used for the phytoplankton identification work, so that no additional sampling efforts are necessary. The water sample collection (field) portion of the phytoplankton project will be covered under the QAPP for the CTDEP project (CTDEP, 2002) (approved May 2002; RFA No. CT02209) (see Appendix D) but is also presented in adequate detail here to provide a complete and cohesive QAPP.

Water samples for phytoplankton identification will be collected on a monthly basis from a minimum of six (six Priority stations) and a maximum of ten (including 4 secondary stations) stations. These stations were chosen based on the availability of existing/historical planktonic community structure data. It is with this overlap of sampling for phytoplankton, pigments, and zooplankton at the same time and location that the best overall information regarding the planktonic community is obtained. All stations to be sampled are also sampled for phytopigment analyses by HPLC, and have historical phytoplankton and phytopigment data associated with them. The phytoplankton community data generated by the current

project will be valuable for interpreting results of this ongoing HPLC phytopigment analyses being conducted by the Monitoring Program under a separate QAPP. The six priority stations to be sampled are also currently being sampled for zooplankton, and have historical data associated with them.

CTDEP conducts supplemental collections each month from June through September and in February and March to capture peak hypoxia and diatom bloom conditions, respectively. While not all stations are sampled during the supplemental surveys, as the focus is the western portion of the Sound, samples for phytoplankton identification will be collected during those surveys as well (*see* table in Section 2.1.1).

All samples will be preserved *in situ* using Lugol's solution and delivered to the University of Connecticut Department of Marine Sciences at Avery Point, Groton, CT (UConn). Under the direction of Dr. Senjie Lin, all phytoplankton samples will be processed and identified to species or genus, when practicable, and enumerated. Phytoplankton analyses are currently funded for a maximum twenty-month period and planned to begin January 31, 2007, pending approval. Data and interpretive reports will be provided to CTDEP along with appropriate QA analyses.

This QAPP will be effective for five years from approval, or approximately through March 2012. At the present time, funding is only available for this project to extend through 2008, hence the 2007-2008 timeframe noted. However, should additional funds become available to continue this work beyond 2008 and within the five-year allowance for QAPP approvals, DEP will submit a letter to EPA indicating the plan to continue this work beyond 2008, with any changes noted.

1.3 Project Organization

The project is organized and coordinated between UConn and CTDEP (**Figure 1**). Dr. Lin will be responsible for ensuring proper field collections made by CTDEP staff, who are supervised by Matthew Lyman of CTDEP. Dr. Lin will also direct and ensure quality for the laboratory procedures, taxonomy, enumeration and interpretation of phytoplankton data. A Research Associate will work under Dr. Lin's supervision on identification and enumeration of phytoplankton. Dr. Lin and Mr. Lyman have already begun to coordinate the planned collection activities and will remain in regular communication during the term of the project. Christine Olsen, CTDEP, will serve as Quality Assurance Officer for the project and will conduct appropriate reviews and audits of the project. Johanna Hunter, EPA Region I, has administrative oversight of the project. All reports and data for the project will be reviewed by CTDEP and EPA - Region I for final approval.

1.4 Distribution List

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1.5 Description of Tasks

Four tasks are specified in the agreement between UCONN and CTDEP.

1. Prepare a QAPP for approval by CTDEP and EPA (Lin, Olsen) (January 2007)
2. Analyze approximately 200 (minimum 184 samples to a maximum of 250) water samples collected by CTDEP from LIS for phytoplankton taxa and abundance (Lin) (January 2007 – June 2008)
3. Create and maintain a database in conjunction with CTDEP (Lin, Olsen) (January 2007 – September 2008)
4. Prepare and submit data reports to CTDEP and the LISS (Lin) (monthly data reports as analyses are completed, and a final data compilation/interpretation report by September 30, 2008).

1.6 Project Report Schedule

Report / [Responsibility]	Date	Items to report
Monthly Data Reports [Prepared by UCONN Principal Investigator and submitted to CTDEP for approval.]	As analyses are completed; but no later than 60 days following receipt of each sample group	1) Accounting of samples analyzed 2) Relevant data (type and number of phytoplankton identified, by sample name) 3) Quality assurance/quality control documentation (document the quality assurance performance and describe any quality assurance issues encountered with reported samples, including any recommendations for corrective action or suggestions that would improve data quality.)
Final Report [Prepared by UCONN Principal Investigator and submitted to CTDEP for approval.].	September 30, 2008	1) A summary of type and number of phytoplankton identified during this project 2) A comprehensive analysis on the spatial and temporal distribution of phytoplankton in Long Island Sound that were collected for this project. 3) A quality assurance section that will document the quality assurance performance and shall describe any quality assurance issues encountered during the project period.
Final Data [Data submittal by CTDEP.]		1) Data will be uploaded to Storet/WQX.

B: MEASUREMENT AND DATA ACQUISITION

2.1 Sample Collection, Storage, and Processing

2.1.1 Schedule of Sample Collection

This QAPP will cover the currently planned and funded twenty-month project beginning on or about January 31, 2007 and continuing through September 30, 2008. The monthly survey for 6 priority plus 4 secondary fixed stations will generally be performed during the first week of each month. In the summer months, June through August, one additional sampling each month will be carried out generally in the third week of the month, but will not cover the entire Sound (*see* Table below). Similarly, supplementary samples will be taken during February and/or March when the diatom bloom usually peaks.

The 10 fixed stations will be a subset of the monthly sampled stations of the CTDEP LIS Ambient Water Quality Monitoring Program (see Appendix D): priority stations B3, D3, F2, H4, I2, and K2; and secondary stations A4, C1, E1, and J2 (**Figure 2**). The distribution of stations and frequency of collection are designed to provide adequate survey coverage of LIS to provide meaningful interpretation of phytoplankton population structure and diversity, complementary to the ongoing monitoring program in LIS and previous phytoplankton

analyses. The original distribution of sampling stations was developed by experts on LIS and monitoring (LISS, 1994 and Connecticut Department of Environmental Protection, 2002).

Sampling locations and number of surveys for phytoplankton collections (*See also* **Figure 1**)												
STN	Jan	Feb*	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Priority Stations												
B3	1	2	1	1	1	2	2	2	1	1	1	1
D3	1	2	1	1	1	2	2	2	1	1	1	1
F2	1	1	1	1	1	1	1	1	1	1	1	1
H4	1	1	1	1	1	1	1	1	1	1	1	1
I2	1	1	1	1	1	1	1	1	1	1	1	1
K2	1	1	1	1	1	1	1	1	1	1	1	1
Secondary Stations												
A4	1	2	1	1	1	2	2	2	1	1	1	1
C1	1	2	1	1	1	2	2	2	1	1	1	1
E1	1	2	1	1	1	2	2	2	1	1	1	1
J2	1	1	1	1	1	1	1	1	1	1	1	1
* Supplementary survey may occur in March, depending on peak bloom observation.												

2.1.2 Sample Collection and Preservation

Water samples (200 ml) will be collected as described in Connecticut Department of Environmental Protection (2002) (see Appendix D) from the surface (2 m below the water surface). The sampling method is discussed in the DEP AWQMP program's Standard Operating Procedures Manual (**SOP**) (see Appendix D). Water samples will be collected with the use of 5-liter Niskin water sampling bottles. The sampling bottles are usually mounted on the General Oceanics Rosette Multibottle Array that allows for remote actuation of the sampling bottles. Sample bottles will be filled during the upcast. When circumstances do not allow the use of the array, sampling bottles will be mounted on a wire controlled by a starboard winch, and triggered with messengers.

Surface samples will be taken at about 2 meter below the surface of the water. A minimum of 10% of the samples will be collected in duplicate (one per survey - randomly assigned).

Sample bottles will be pre-marked with water-resistant tape for the level of 200 ml. In the field, bottles will be filled up to the mark with the water sample collected as described above. Four ml of Lugol's solution will be added to each sample (to reach 2% final concentration). Samples thus preserved will be kept at 4 °C in darkness and delivered to the Avery Point campus of University of Connecticut. At UConn, samples will be stored at 4 °C in the dark until processing. Lugol's solution will be prepared following modified Utermohl (1958) by Dr. Lin one week prior to survey and provided to the CTDEP field personnel. The Lugol's solution consists of 4 g Iodine (I2) and 6 g Potassium Iodide (KI) in 100 ml solution stored in a light-shielding bottle.

Ancillary field data are collected and recorded as part of DEP's regular monitoring effort. Parameters of relevance to the phytoplankton monitoring include date, time and depth of sample, temperature and salinity profiles, light attenuation, and general sea and weather

conditions. Weather conditions are generally noted although wind speed and direction are not measure on board the ship, but will be obtained from the nearest meteorological station. Tide information will be taken from tide tables based on the time of sample collection. Current measurements are not taken on these surveys.

2.1.3 Sample Handling, Tracking and Custody

All samples will be identified with a unique sample identification number (shorthand of station name, collection date (MM/DD/YYYY), time (24 hour basis) labeled on the sample bottles and recorded in field notebooks. In the notebook additional information will be entered, including general weather observations, water temperature and salinity. Data sheets will accompany the samples in the same manner as specified in the CTDEP QAPP (see Appendix D) for LIS sampling for water chemistry samples and will be entered into a computer database. These sample data will be copied into a database that will be created in Dr. Lin's laboratory (for example, see Appendix A). Since these procedures are routine with the water chemistry samples, no problems with sample handling and delivery are anticipated.

Once arriving at Avery Point, samples will be gathered in cardboard boxes, one for each month. Boxes will be covered to prevent light exposure and stored in the 4°C dark room in the Marine Science Building. Sample processing (see Section 2.1.4, below) will generally occur within 60 days of sample receipt, in order to meet the requirement of monthly data report submittals.

After the sample has been processed, the remaining sample will be archived and stored in the same way in case subsequent analysis is needed or desired. Before archiving, water level will be marked on the bottle using a water-resistant marker so that any possible evaporation will be noted and volume will be calibrated accordingly. In addition, color of the sample will be checked monthly for possible loss of iodine. If fading of the color is observed, 1 ml of fresh Lugol's solution (for recipe see 2.1.2) will be added. Samples can be kept for over six months under this condition. In this project, we do not intend to store samples longer than 60 days prior to analysis. Field sample data sheets will accompany samples to ensure chain of custody tracking requirements are met.

2.1.4 Sample Processing

Sample analysis will proceed in a "first in, first out" order to minimize and even out storage time for all samples. Sample processing will follow a method that is widely used for phytoplankton monitoring projects (e.g. Standard Operating Procedure for Phytoplankton Analysis of Grace Analytical Lab, Chicago, IL, 1994). Fifty mL-subsamples will be concentrated using Utermohl Settling Chamber for 24 hours. The concentrated then will be examined using an inverted microscope equipped with 10 and 40 x magnification on the objective and 10 x in the eye piece to achieve up to 400 x magnification. Phytoplankton will be identified to species or genus for diatoms whenever possible, or class or family otherwise.

For ultra phytoplankton (<5 μm) whose species or family identity may be difficult, classification will be made based on autofluorescence of chlorophyll and other pigments, e.g. phycoerythrin containing cyanobacteria. The lower detection limit is about 2 cells/ml. The precision criterion for acceptance of analysis will be within 10% of the counts. No special

treatment will be done to the samples, but use of iodine as preservative (Lugol's solution) will aid in identifying certain taxa.

If it turns out necessary to perform scanning electron microscopy to identify diatom species that are important in the sample, efforts will be made to do so, after discussion with DEP on the additional cost needed. To ensure consistency, only one personnel, the research associate, will process the samples, while Dr. Lin will perform quality assurance and control check on a regular basis.

2.1.5 Phytoplankton Identification and Enumeration

Phytoplankton will be identified using standard keys representative of the flora of the area. Previously documented phytoplankton composition for western, central, and eastern Long Island Sound (Capriulo et al. 2002) will be consulted. Primary annotated references include "Identifying marine phytoplankton," (Tomas 1997) and "Marine Phytoplankton: A guide to naked flagellates and coccolithophorids" (Tomas 1993), Schnitzer (1979), Griffith (1961), Wood and Lutes (1968), and Marshall (1981), Weiss (1995), Capriulo et al. (2002), but other keys will be followed when necessary. If difficulties are encountered, aliquots of samples will be sent to experts at the Graduate School of Oceanography of the University of Rhode Island to ensure correct identification (e.g. Drs. Sieburth and Smayda). The research associate will be doing most of the identification work, but Dr. Lin will review all data and conduct random identifications and counts on at least one sample from each survey as a quality assurance check (*See* Section 2.3.2).

Cells identified as described above will be enumerated on the inverted microscope using standard Sedgewick-Rafter counting technique. Whenever possible, 400 or more cells will be counted for each species. If cell concentration is too low to reach this number, the highest possible number (covering ten swipes of the Sedgewick-Rafter counting cell) will be counted. Attention will be given to low cell counts in data analysis, with reference to Venrick (1978). Results will be recorded in an Excel spreadsheet as shown in Appendices B & C.

2.2 Data Analysis and Report Submission

2.2.1 Spatial and Temporal Variation

The fundamental analysis of the data will involve spatial and temporal interpretation of phytoplankton species composition and abundance. Much of this information will be presented in a variety of graphical formats including bar charts, line graphs, and distributional mapping. More statistical analyses may be desirable and the exact type of statistics that best fit the data sets will be determined when all the samples are processed.

2.2.2 Reports

Reports will be submitted to CTDEP, and forwarded by CTDEP to EPA, for review and acceptance. Reports will be produced according to the schedule outlined in Section 1.6. In addition to the text reports, UConn will provide data in a database format approved by CTDEP to be compatible with CTDEP's existing database for the LIS Water Quality

Monitoring Program. CTDEP will be responsible for maintaining the database upon completion of the Phytoplankton Project. Data to be reported will include identity (species or higher taxonomic levels) and concentration of each taxon (cells/L). Metadata included with the sample identification results will include relevant collection information (date, time, location, depth) and any appropriate qualifiers of sample integrity. Examples of sample data and analytical results reports are shown in Appendices A, B & C. Field records will be maintained as described in Connecticut Department of Environmental Protection (2002).

2.3 Quality Control Requirements and Corrective Measures

2.3.1 Sampling Quality Control

The sampling and sample handling procedures to be followed have been performed previously by Mr. Lyman. New staff of the DEP Monitoring Program will be trained as necessary for any new tasks and training will be documented. By duplicating 10% or more of the samples (1-2 stations per sampling event), Dr. Lin will have the opportunity to observe any anomalies (e.g. incorrect volume of sample, unusually high or low phytoplankton biomass, unusual similarity of phytoplankton species composition and abundance between stations, etc.) that might be related to sample collection and relate appropriate corrective measures to the monitoring staff. Also, any problems with preservation, volume, or handling will be reported immediately to CTDEP upon checking the samples at the laboratory so appropriate corrective action may be taken.

2.3.2 Analytical (Identification) Quality Control

As part of the analytical protocol, Dr. Lin and his staff will add to a reference collection of all taxa, or photographs or drawings of each taxon, identified during the project period that were not previously catalogued. In the case of uncertain identification, area experts in those taxa will be consulted for confirmation if necessary (e.g. Dr. Sieburth and Smayda at GSO of the University of Rhode Island). As noted above, Dr. Lin will review results and note any unusual species, counts, or findings. He will also re-identify at least one sample from each survey to provide a cross check of the identification process. To minimize variation, only one staff (research associate) will perform the primary identification and enumeration of samples, with Dr. Lin providing oversight, and cross-checking a minimum of 10% of samples.

In the event that the cross-check analyses show significant deviations in the dominant taxa observed (with higher than 10% difference in phytoplankton counts, *see* Section 2.1.4), Dr. Lin and his research associate will work through the problem samples together to ensure proper identifications are being made, enumeration techniques are appropriate, and any other sources of error are resolved. Then the samples that show such significant deviations will be re-analyzed. All samples, or aliquots of the samples, will be archived for the term of the project, until the final report is completed and approved.

2.4 Performance Audits

Performance will be audited internally as noted above, through review of the data by the Principal Investigator, Dr. Lin. External audits will be conducted by CTDEP staff, under the supervision of Christine Olsen, through the review of the quarterly and annual reports provided by Dr. Lin. Other audits may be conducted by EPA and the LISS during their review of the periodic reports, or through visitation of the UConn lab or on board the R/V *Dempsey*, if desired.

2.5 Data Management

The Principal Investigator will be responsible for creating a database of all identifications and counts using a standard software such as Access or Excel in a format compatible for transfer into the CTDEP LIS Monitoring Program database. CTDEP will be responsible for long-term maintenance of the database upon completion of the project. CTDEP will also be responsible for uploading data from this project into WQX, the web accessible system replacing STORET.

C: ASSESSMENT AND OVERSIGHT

3.1 Assessments

Internal assessments will be conducted as described above, through periodic sample cross-checks (1-2 samples per survey) and review between Dr. Lin and his research associate. External assessments will be handled by CTDEP through regular contact and communication about any problems that arise and corrective actions that need to be taken. The most detailed external assessments will be conducted through review of the data and periodic reports as they are submitted to CTDEP and the LISS. Any and all field or laboratory protocols that need to be adjusted will be discussed between UConn and CTDEP and an appropriate action decided upon and taken.

3.2 Management Reports

Dr. Lin will alert CTDEP to any problems with missing or compromised samples as soon as noted after each survey so that corrective action can be taken. Similarly, if laboratory identification problems are encountered, Dr. Lin will contact CTDEP for advice and resolution options. All such problems will be reported in the next quarterly report along with the corrective action taken and an indication of whether the corrective action has solved the problem.

D: DATA VALIDATION AND USABILITY

In this type of project, many of the taxonomic identification quality assurance procedures provide good certainty that the data are both valid and usable. However, each survey's data will be reviewed by Dr. Lin, and on a quarterly basis by CTDEP, for compliance, correctness, completeness and consistency. Unusual taxon identifications or dominance will be reviewed and checked to ensure correctness.

Any missing samples or laboratory accidents will be reported to record completeness and results will be further reviewed to be sure they are consistent with expected phytoplankton community structure in the area.

Any unusual observations will be reviewed by UConn and CTDEP staff involved in the project and, if warranted, outside expertise will be consulted to resolve any problems with data validation and usability. Because samples or sample aliquots will be retained until the study is completed, questionable samples can be re-analyzed to resolve any problems.

E: LITERATURE CITED

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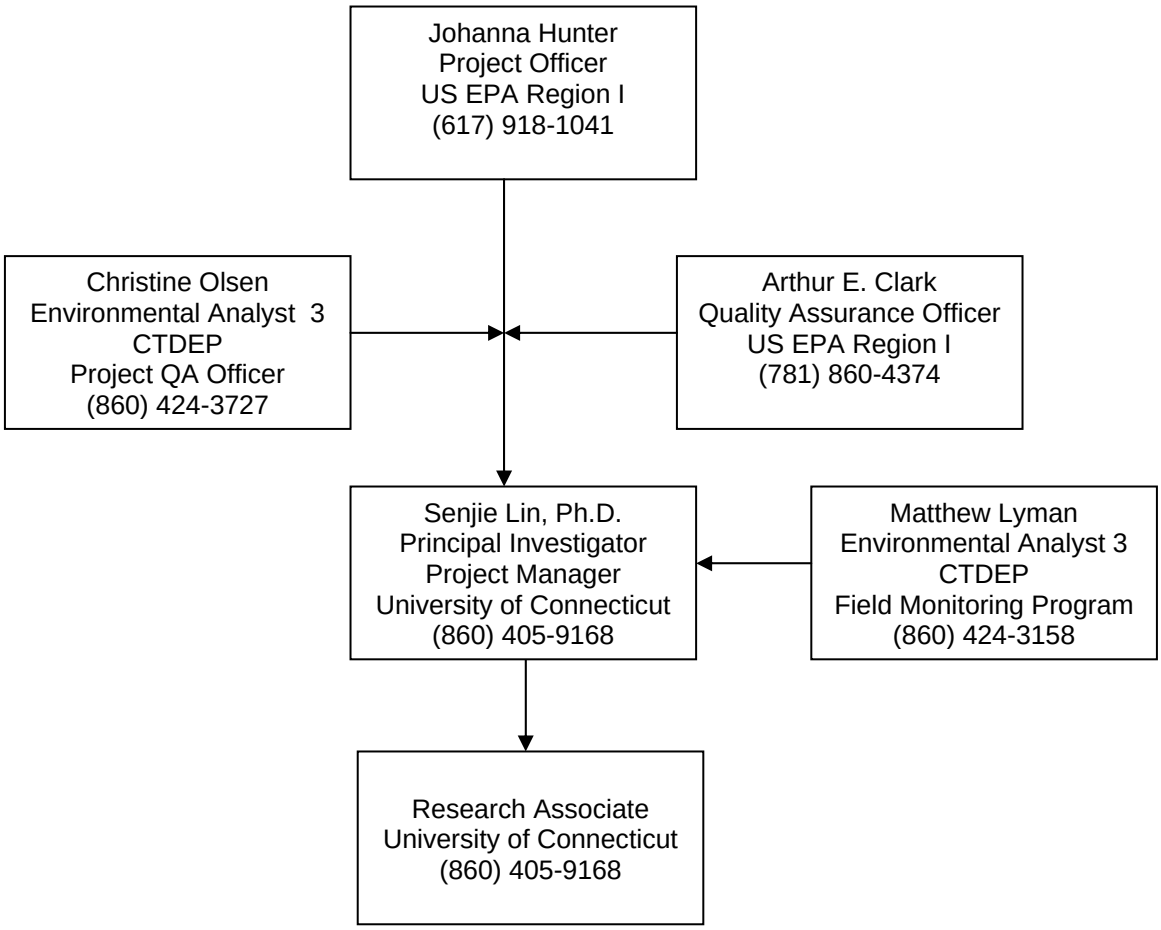

Figure 1. Organization Chart for Phytoplankton Project.

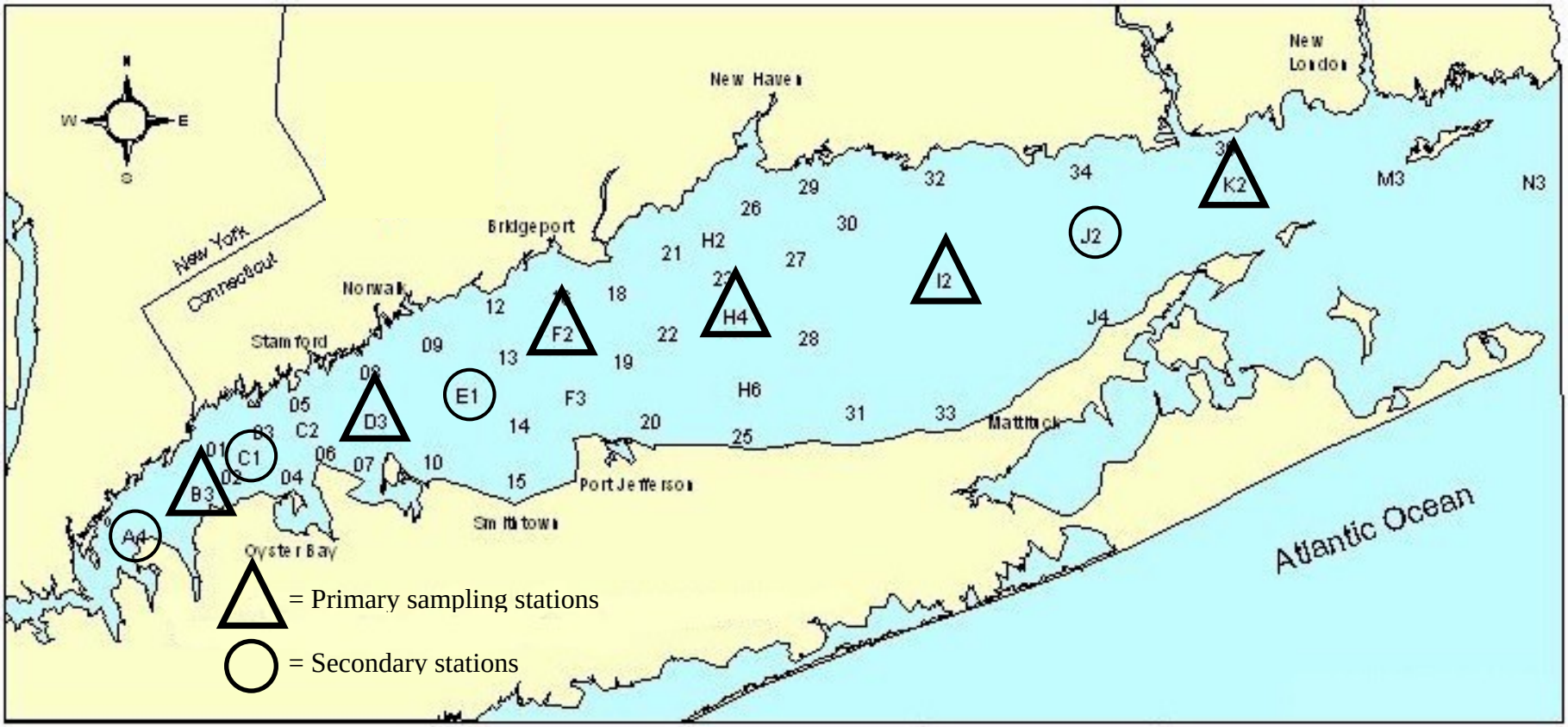

Figure 2. Long Island Sound sampling stations for phytoplankton study. The 10 stations selected to provide adequate survey coverage of LIS to allow meaningful interpretation of phytoplankton population structure and diversity and to coincide with other plankton community sampling (zooplankton and phytopigment).

APPENDIX A.

TABLE 1. SUMMARY OF SAMPLING INFORMATION

Table 1. Summary of Sampling Information

Location: Long Island Sound
Date of Sampling:

Station	Lat/Longt.	Depth	Temperature(^{o}C)	Salinity ($^{o}/_{oo}$)	Weather	# of samples	Sample ID [station, date (MM/DD/YYYY), sample #]

APPENDIX B.

TABLE 2. PHYTOPLANKTON ANALYSIS

Place:					Sample ID:		
Analyzed by:					Station Number:		
Date Analyzed:					Date Collected:		
Method used:							

Taxon	Raw count	Cells/mL	Cell shape	Average Cell Dimensions			# of cells
				length	width	diameter	measured

APPENDIX C.

TABLE 3. SUMMARY OF PHYTOPLANKTON COUNTS

Place:
Analyzed by:
Date Analyzed:
Method used:

Sample ID:
Station and depth:
Date Collected:

TOTALS	cells/mL
Picoplankton	
Cyanophyta (Blue-greens)	
Chlorophyta (Greens)	
Chrysophyta (Golden Browns)	
Cryptophyta	
Pyrrhophyta (Dinoflagellates)	
Euglenophyta	
Xanthophyta (Yellow greens)	
Chloromonadocnyta (Chloromonads)	
Unidentified flagellates and coccoids	
Bacillariophyta (Diatoms-Live cells)	
Total	

Dominant species:
_____
_____
_____
_____

Area scanned: _____ mm^2
Volume settled: _____ mL
Original volume: _____ mL

BIOGRAPHICAL SKETCH

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Education

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Xiamen University, China, M. S., Marine Biology, 1987
State University of New York at Stony Brook, Biological Oceanography, Ph. D., 1995

Professional Society Membership

American Association for the Advancement of Science
American Society of Cell Biology
Phycological Society of America
International Society of Phycology
American Association of Limnologists and Oceanographers

Professional Experience

2005-present Associate Professor, University of Connecticut
1999-2005 Assistant Professor, University of Connecticut
1997-2001 Adjunct Assistant Professor, SUNY @ Stony Brook
1995-1997 Postdoctoral Research Associate, SUNY @ Stony Brook
1990-1995 Research Assistant, SUNY@ Stony Brook
1987-1990 Research Scientist, Xiamen University, China

Five Pertinent Publications

Zhang, H., Hou, Y., Miranda, L., Campbell, D. A., Sturm, N. R., Gaasterland, T. and **Lin, S.** 2007. Spliced leader RNA *trans*-splicing in dinoflagellates. Proc. Nat. Acad. Sci. U. S. A. 104: 4618-4623.

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Lin, S. and Corstjens, P. L. A. M. 2002. Molecular cloning and expression of the Proliferating Cell Nuclear Antigen gene from the coccolithorid *Pleurochrysis carterae* (Haptophyceae). J. Phycol. 38: 164-173.

Five Other Publications

Zhang, H., Bhattacharya, D. and **Lin, S.** A three-gene dinoflagellate phylogeny suggests monophyly of Prorocentrales and a basal position for *Amphidinium* and *Heterocapsa*. J. Mol. Evol. (accepted).

Lin, S., Zhang, H. and Jiao, N. 2006. Potential utility of mitochondrial cytochrome *b* and its mRNA editing in resolving closely related dinoflagellates: a case study of *Prorocentrum* (Dinophyceae). J. Phycol. 42: 646-654.

Zhang, H. Bhattacharya, D. and **Lin, S.** 2005. Phylogeny of Dinoflagellates Based on Mitochondrial Cytochrome *b* and Nuclear Small Subunit rDNA Sequence Comparisons. J. Phycol. 41: 411-420.

Zhang, H. and **Lin, S**. 2003. Complex gene structure of the form II Rubisco in the dinoflagellate *Prorocentrum minimum* (dinophyceae). J. Phycol. 39: 1160-1171.

Lin, S., Zhang, H., Spencer, D., Norman, J. and Gray, M. W. 2002. Widespread and extensive editing of mitochondrial mRNAs in dinoflagellates. J. Mol. Biol. 320:727-739.

Synergistic activities

a. Journal Editorial Board

American Journal of Plant Physiology (2006-present).
Acta Oceanologica Sinica (2004-present).

b. Guest Professorship

Guest Professor, Xiamen Univeristy (2006-present)
Guest Professor, The South China Sea Institution of Oceanology, Chinese Academy of Sciences (2005-present)
Advisory Professor, Shanghai Fisheries University (April 2003-present)

c. Review manuscripts for scientific journals

Applied and Environmental Microbiology, Aquatic Microbial Ecology, Harmful Algae, Hydrobiologia, Indian Journal of Marine Sciences, Journal of Experimental Marine Biology and Ecology, Journal of Phycology, Journal of Applied Phycology, Journal of Phycological Research, Limnology and Oceanography, Marine Biotechnology, Protist, Nucleic Acid Research, Estuaries and Continental Shelf, Molecular Biology and Evolution.

d. **Grant proposal reviewer and Panelist**

NSF (panelist Oct 2006), NOAA, NIH (panelist Nov 2005), Delaware Sea Grant, New Hampshire Sea Grant, Louisiana Sea Grant, Woods Hole Sea Grant.

Collaborators in past four years

E. J. Carpenter (SFSU), P. Costjiens (U. Leiden), M. McKay (BGU), G. McManus (UConn), B. Bergman (Stockholm Univ.), M. W. Gray (Dalhouse Univ.), C. Glober (Southampton College).

Graduate Advisors

Ph. D. advisor: Dr. E. J. Carpenter
M. S. advisor: Professor Song Li

Students and postdoc

Tim Feinstein (Masters, UConn), Sheri Henze (undergraduate, University of Maine), Keri Costa (underdraduate, UConn), Yucheng Ni (postdoc, NIH), Huan Zhang (postdoc, U Conn.), Paola Batta Lona (M. S., U Conn), Yubo Hou (Ph. D., U Conn), Lilibeth Miranda (Ph. D., U Conn), Christina Haska (M.S., U Conn).